Lesson Plan – Plant Reproduction

Stephanie Smith and Aliya Waheed

|  |  |  |
| --- | --- | --- |
| Unit: Plants: Anatomy, Growth, and Function Grade: 11 University Preparation (3U) | | |
| Lesson Sequence | Lesson Plan Topic | Names |
| Fifth Lesson | Succession | Saralyn |
| Sixth Lesson | Biodiversity | Anu and Sam |
| Seventh Lesson | Plant Reproduction | Stephanie and Aliya |
| Rationale: These lessons comprise much delivered content in our plant unit, and overall contribute to students’ understanding of the course’s big ideas:   * Plants have specialized structures with distinct functions that enable them to respond   and adapt to their environment.   * Plant variety is critical to the survival and sustainability of ecosystems.   Each lesson’s topic involves an understanding of humans’ role in sustaining plant life and the importance of stewardship. These lessons come relatively early in the unit and will serve as models for presenting information, especially as students will give their own presentations late in the unit.  Our lesson on Plant Reproduction furthermore provides students an opportunity to use multiple materials and different media to research a topic and synthesize information into a usable format.  In learning about different methods of plant reproduction, students will identify examples of specialized structures and functions of plants, and compare how these methods contribute to biodiversity. An understanding of both sexual and asexual reproduction techniques will also highlight the advantages and disadvantages in terms of the sustainability of each practice. | | |

**Looks Like:**

* Students will use Fact Sheets from all

other groups and completed Summary Charts to

complete homework questions connecting

big ideas (Student handout sheet Appendix 7)

* Each group briefly presents their method using their whiteboard drawing.
* Hand out Comparison/ Summary Chart (Appendix 6) to students and have it on overhead.
* Fill out the chart as a class and call on the group who did each topic to provide the required information.
* Ask class to raise their hands if a method increases biodiversity (repeat for all methods). Discuss as a class.
* Collect students’ Fact Sheets before they leave; they will be distributed via online site to the rest of the class (after the teacher checks them over for accuracy).

**Rationale for choice of T/L Strategy:**

* Activates prior knowledge for the purposes of highlighting skills needed to investigate the new material
* Assesses prior knowledge and readiness
* Make connections between prior knowledge and new knowledge that is to be learned

**Rationale for choice of T/L Strategies:**

* Allows students to explore and investigate (and struggle) with a new concept prior to ‘being told’
* Different types of resources will cater to students with different learning styles
* Allows students to communicate and discuss
* Allow students to construct new knowledge
* Allows students to develop concepts using higher order thinking skills
* Allows teacher time to interact with students, differentiate and assess for learning
* Allows teacher to identify and challenge student misconceptions
* White boards will give the class a visual representation of reproductive process
* Assesses each groups’ understanding of reproductive method

**Rationale for choice of T/L Strategy:**

* To review new knowledge
* To structure new knowledge in a scaffold that highlights which criteria students are expected to know for each method
* To connect entire content of the lesson together so students can see big picture
* To identify common errors
* To assess as learning and reflect on learning (metacognition)
* To connect this lesson with previous learning on biodiversity

**Unit and Title of Lesson: Plants: Anatomy, Growth, and Function (Grade 11) 🡪 Plant Reproduction**

|  |  |
| --- | --- |
|  |  |
|  |  |
|  |  |

Curriculum Connections

* Big Ideas: Plants have specialized structures with distinct functions that

enable them to respond and adapt to their environment

* Ministry Expectations: F2.4; F3.3; A1.3; A2.1
* Learning Goal: Students will investigate and compare methods of plant

reproduction.

|  |  |
| --- | --- |
| **List Materials**   * Lab Equipment * Technology needs * Audio visual | **Include in Appendix**   * Instructions for students * Scaffolding support * Handouts |

**Time: 10 mins**

**Before: Minds On**

**Time: 40 mins**

**During: Action**

**Time: 20 mins**

**After: Consolidation & Connection**

**Next Steps**

**Assessment Strategies: Minds-On checks for prior knowledge and any general misconceptions; during Action, teacher checks understanding on an individual basis while circulating as students complete their Fact Sheets; during Consolidation, teacher checks for understanding using questions that summarize each reproductive method.**

**Time: 5 mins**

**Rationale for Choice of T/L Strategy:**

* To highlight the big picture of plant reproduction
* To identify common errors/misconceptions
* To prepare for next class’ discussion
* To assess as learning and reflect on learning ion)
* Divide students into 6 groups of 4-5 students each (have done prior to lesson according to ability levels and class dynamics). Each group will investigate one method of reproduction.
* Give students resources (use complexity ratings to differentiate learning); each student spends about 10 minutes with his/her own resource.
* During this time, teacher circulates to work with students individually or as a small group to check understanding and provide assistance.
* Get the group to discuss what they learned from their resources; make sure they all have an understanding of their method.
* Get the group to fill in a Fact Sheet (Appendix 3) for their method.
* Each group draws out the process of their method on whiteboards.
* Advise each group will they be called upon to explain their reproductive process using their whiteboards.
* Introduce concept by asking students to recall a time they saw plants reproduce or helped in facilitating reproduction (i.e. gardening) 🡪 “Think-Pair-Share”
* ask students to discuss the different ways plants grow 🡪 “Think-Pair-Share”
* discuss students` experiences as a class

Appendix 1 – Additional/Teacher notes for lesson plan

**Plant Reproduction**

Grade 11 Biology; 75 mins

Curriculum Expectations:

* A1.3 identify and locate a variety of print and electronic sources that enable them to address research topics fully and appropriately
* A2.1 identify and describe a variety of careers related to the fields of science under study (e.g., zoologist, botanist, geneticist, ecologist, pharmacologist, farmer, forester, horticulturalist) and the education and training necessary for these careers
* F2.4 investigate various techniques of plant propagation (e.g., leaf cutting, stem cutting, root cutting, seed germination) [PR]
* F3.3 explain the reproductive mechanisms of plants in natural reproduction and artificial propagation (e.g., germination of seeds, leaf cuttings, grafting of branches onto a host tree)

Learning Goals:

* Students will learn natural and artificial reproductive processes in plants
* Students will be able to make connections between type of reproductive process and genetic variability in plants
* Students will learn advantages/disadvantages of natural/artificial and sexual/asexual reproduction
* Students will understand plant propagation techniques in terms of how they contribute to biodiversity

Prior Knowledge:

* Students will be familiar with meiosis (from grade 11 unit on Genetic Processes), mitosis (from grade 10 unit on Tissues, Organs, and Systems of Living Things), how sexual reproduction increases genetic diversity (from grade 11 unit on Genetic Processes), biodiversity (from previous lesson in grade 11 Plant unit)

Materials Required:

* Overview of Plant unit (Appendix 2; page 4)
* Fact Sheet handout (Appendix 3; page 5)
* Resource Handout Table (Appendix 4; page 6)
* Resource Handouts (Appendix 5; pages 7-67 🡪see Resource Handout Table for more information)
* Comparison Chart handout and on overhead; blank and filled charts included (Appendix 6; pages 68-69)
* Homework Question Sheet (Appendix 7; page 70)

Technology Required:

* 2 classroom computers/iPads/iPhones/etc for watching video resources
* Overhead projector
* Transparency markers
* 6 white boards with markers

Appendix 2

Unit Outline (SBI3U Plants)

1.Introductory (News link to Society/Technology) (F1, F1.1, F1.2)

2.Introduce Project and Growth Lab (F2, F2.1, F2.2)

3.Growth Lab Field Day (getting ideas, will like to conclusion) (several)

4.Begin Growth Lab/Plants Mind Mapping (F2, F2.1, F2.2)

5.Succession (F3.4, F3.5) -- Saralyn

6.Biodiversity (+Succession) (F3.5, F3.4) -- Anu and Sam

7.Plant Reproduction (F2.4, F3.3) -- Aliya and Stephanie

8.Monocots/Dicots (F3.2, F3.3)

9.Computer Research Day (for Projects)

10.Introduce Plant Tissues (F2.3, F3.1)

11.Transportation of Nutrients (etc.) in Plant (F2.3, F3.1)

12.Plant Tissue Microscope Lab (F2.3, F3.1)

13.Work Class (prep for presentations, finish tissue lab write up)

14.Presentations (F1.1)

15.Presentations (F1.2)

16.Finish Growth Lab (F2, F2.1, F2.2)

17.Review

18.Summative Test

Appendix 3

**Plant Reproduction Fact Sheet**

Type of Plant Reproduction: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Explain how this method of reproduction occurs in five steps:

1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
5. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Asses and explain whether this method:

1. uses mitosis or meiosis: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. produces a genetically distinct individual: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. is an example of asexual or sexual reproduction: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Does this method of reproduction occur naturally or with human interference? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Example species that uses/is made to use this method: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

How does this method of reproduction impact human industry? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Appendix 4

Resource Handout Table

|  |  |
| --- | --- |
| Method of Reproduction | Resources - Description; length (Complexity 1 [low] - 5 [high]) |
| Angiosperm  Pollination | 1. Eureka Alerts Article - Pollinators and Sustainability; 3 pages (3)  2. Diagram of sexual reproduction process; 1 page (5)  3. Odyssey Adventures in Science Magazine article; 3 pages (4)  4. Fact sheet on value of pollinators and steps to protect them; 2 pages (3)  5. Parts of a flower, pollination, and seed formation; 6 pages (1) |
| Gymnosperm Pollination | 1. Students' textbook  2. Summary of gymnosperm characteristics from university textbook; 1 page (2)  3. Article on conifers in Boreal Forest; 4 pages (5)  4. Video: “Seed Production in Gymnosperm”; 1.5 minutes (4)  5. Odyssey Adventures in Science Magazine article; 2 pages (3) |
| Seed Germination | 1. Overview of seed dormancy from university textbook; 2 pages (5)  2. Explanation in gardening book; 4 pages (4)  3. List of things needed for seeds to germinate; 2 pages (3)  4. Illustrations of germination process; 2 pages (2)  5. Description of seed germination and seeds in Plant Life Book; 4 pages (1) |
| Leaf Cutting | 1. Students' textbook  2. How-to guide on technique; 2 pages (3)  3. Overview of asexual reproduction techniques in plants; 2 pages (1)  4. Article on how to propagate houseplants using leaf cuttings; 2 pages (3)  5. Description of method from textbook; 1 page (3) |
| Root Cutting | 1. Students' textbook  2. Explanation and how-to; 2 pages (3)  3. Article on propagating rhubarb; 3 pages (5)  4. Article on how to grow new plants from root cuttings; 2 pages (3) 5. Video: “Root Cuttings”; 7 minutes (2) |
| Grafting | 1. Students' textbook  2. Explanation from gardening book; 2 pages (3)  3. How-to guide from gardening book; 3 pages (2)  4. Article on grafting designer trees in NYC; 2 pages (4)  5. "How to Graft" online article from Toronto Botanical Garden; 4 pages (5) |

Appendix 5 – Resources (listed in order given in Resource Handout Table)

Angiosperm Pollination #1

http://www.eurekalert.org/pub\_releases/2006-10/uoc--pho102506.php#

**Public release date: 25-Oct-2006**  
  
Contact: Sarah Yang  
[University of California - Berkeley](http://www.berkeley.edu)

**Pollinators help one-third of the world's food crop production**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| http://www.eurekalert.org/images/clear.gif | | | | |
| http://www.eurekalert.org/images/clear.gif | http://www.eurekalert.org/images/corner_tl.jpg | http://www.eurekalert.org/images/clear.gif | http://www.eurekalert.org/images/corner_tr.jpg | http://www.eurekalert.org/images/clear.gif |
| http://www.eurekalert.org/images/clear.gif | http://www.eurekalert.org/images/clear.gif | [http://www.eurekalert.org/multimedia/pub/rel/2236_rel.jpg](http://www.eurekalert.org/multimedia/pub/2236.php?from=85828)  [[http://www.eurekalert.org/images/eutube/icon_image_tiny.gif](http://www.eurekalert.org/multimedia/pub/2236.php?from=85828)**IMAGE:**](http://www.eurekalert.org/multimedia/pub/2236.php?from=85828)Shown is a blue orchard bee, *Osmia aglaia* Sandhouse, visiting a Himalayan blackberry, *Rubus praecox Bertol*. This species of blackberry is heavily reliant upon bees for pollination....  [Click here for more information.](http://www.eurekalert.org/multimedia/pub/2236.php?from=85828) | http://www.eurekalert.org/images/clear.gif | http://www.eurekalert.org/images/clear.gif |
| http://www.eurekalert.org/images/clear.gif | http://www.eurekalert.org/images/corner_bl.jpg | http://www.eurekalert.org/images/clear.gif | http://www.eurekalert.org/images/corner_br.jpg | http://www.eurekalert.org/images/clear.gif |
| http://www.eurekalert.org/images/clear.gif | | | | |

Berkeley -- Pollinators such as bees, birds and bats affect 35 percent of the world's food crop production, increasing the output of 87 of the leading crops worldwide, finds a new study published today (Wednesday, Oct. 25), in the Proceedings of the Royal Society B: Biological Sciences and co-authored by a conservation biologist at the University of California, Berkeley.

The study is the first global estimate of food crop production that is reliant upon animal pollination. It comes one week after a National Research Council (NRC) report detailed the troubling decline in populations of key North American pollinators, which help spread the pollen needed for fertilization of such food crops as fruits, vegetables, nuts, spices and oilseed.

Of particular concern in the NRC report was the decline of the honey bee, a species introduced from Europe and a critical pollinator for California's almond industry. The report pointed out that it takes about 1.4 million colonies of honey bees to pollinate 550,000 acres of this state's almond trees.

In an effort to better understand how dependent crop production is upon pollinators worldwide, an international research team led by Alexandra-Maria Klein, an agroecologist from the University of Goettingen in Germany, conducted an extensive review of scientific studies from 200 countries and for 115 of the leading global crops.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| http://www.eurekalert.org/images/clear.gif | | | | |
| http://www.eurekalert.org/images/clear.gif | http://www.eurekalert.org/images/corner_tl.jpg | http://www.eurekalert.org/images/clear.gif | http://www.eurekalert.org/images/corner_tr.jpg | http://www.eurekalert.org/images/clear.gif |
| http://www.eurekalert.org/images/clear.gif | http://www.eurekalert.org/images/clear.gif | [http://www.eurekalert.org/multimedia/pub/rel/2237_rel.jpg](http://www.eurekalert.org/multimedia/pub/2237.php?from=85828)  [[http://www.eurekalert.org/images/eutube/icon_image_tiny.gif](http://www.eurekalert.org/multimedia/pub/2237.php?from=85828)**IMAGE:**](http://www.eurekalert.org/multimedia/pub/2237.php?from=85828)Raspberries, *Rubus ideaus L*, after passive self-pollination (left and middle) and open insect pollination (right).  [Click here for more information.](http://www.eurekalert.org/multimedia/pub/2237.php?from=85828) | http://www.eurekalert.org/images/clear.gif | http://www.eurekalert.org/images/clear.gif |
| http://www.eurekalert.org/images/clear.gif | http://www.eurekalert.org/images/corner_bl.jpg | http://www.eurekalert.org/images/clear.gif | http://www.eurekalert.org/images/corner_br.jpg | http://www.eurekalert.org/images/clear.gif |
| http://www.eurekalert.org/images/clear.gif | | | | |

Claire Kremen, an assistant professor at UC Berkeley's Department of Environmental Science, Policy, and Management, is co-author of this new study.

"There's a widely stated phrase in agriculture that you can thank a pollinator for one out of three bites of food you eat," said Kremen, who is also a member of the Committee on Status of Pollinators that produced the NRC report and leader of a group at the National Center for Ecological and Analysis and Synthesis that co-sponsored the work. "However, it wasn't clear where that calculation came from, so we set out to do a more thorough and reproducible estimate, and we wanted to look at the impact on a global scale."

What the researchers found fell in line with the dictum to which Kremen referred. Out of the 115 crops studied, 87 depend to some degree upon animal pollination, accounting for one-third of crop production globally. Of those crops, 13 are entirely reliant upon animal pollinators, 30 are greatly dependent and 27 are moderately dependent.

The crops that did not rely upon animal pollination were mainly staple crops such as wheat, corn and rice.

The NRC report notes that honey bees in North America have been decimated by infestations of parasitic mites that were inadvertently introduced to the United States. In addition, honey bees are battling antibiotic-resistant pathogens and competition from Africanized honey bees.

Kremen added that honey bees, particularly ones in the wild versus those in managed hives, are negatively impacted by habitat loss and a variety of non-sustainable farming practices. These impacts also affect native species of wild bees. There are 4,000 species of native bees in North America alone.

"We've replaced pollination services formerly provided by diverse groups of wild bees with domesticated honey bees," said Kremen, who recently co-authored another study showing that wild bees interacting with honey bees can lead to a five-fold increase in pollination efficiency. "The problem is, if we don't protect the wild pollinators, we don't have a backup plan."

Kremen suggested an approach to a more sustainable form of agriculture, one that de-emphasizes the use of synthetic fertilizers and builds in more of a reliance on natural ecosystems.

Some changes may involve mere tweaks to current practices, such as allowing weeds and native plants to grow and prosper along the border of the primary crop, she said. Such non-crop plants, which are currently killed off by herbicides, can sustain a variety of wild bee species when the primary crops are not in bloom.

Another change could be to switch from flood irrigation, which drowns bee species that nest in the ground, to spray irrigation when feasible, said Kremen.

The study in the Proceedings of the Royal Society B highlights what is at stake if steps to improve pollinator biodiversity are not taken.

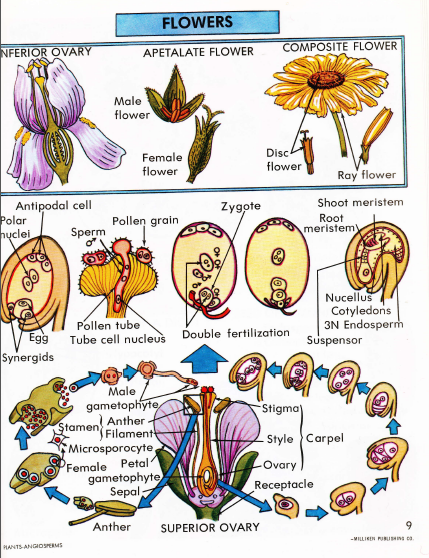
"Passion fruits in Brazil are hand-pollinated through expensive day-laborers as the natural pollinators, carpenter bees, are hardly available because of high insecticide use in the agricultural fields and the destruction of the natural habitats," said lead author Klein.

Klein said that in the cities of Brazil, the high prices for fruits and vegetables are pushing people to turn to less healthy alternatives, including fatty meats and sugar products. As a result, she said, obesity rates seem to be rising.

"The stability of crop yields not only depends on pollination, but also on further ecosystem services," Klein added. "Therefore, we need landscapes carefully managed for a diversity of functionally important groups of organisms that sustain many important ecosystem services such as pollination, pest, pathogen and weed control, and decomposition."

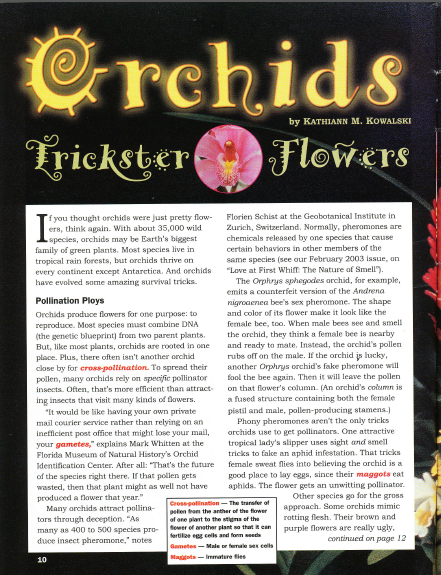
Angiosperm Pollination #2

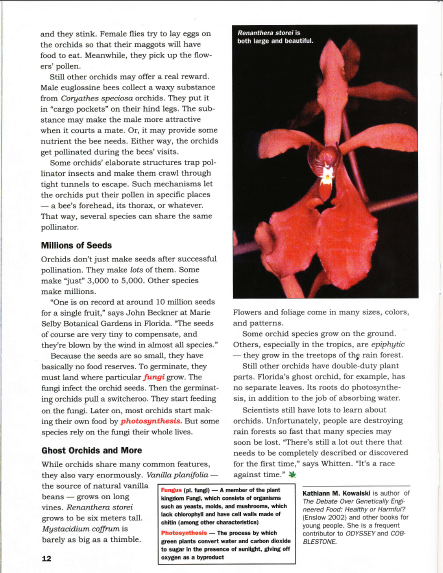
From: Leftwich, R. (1986) *Plants – Angiosperms.* St. Louis, MO: Milliken Publishing Company.



Angiosperm Pollination #3

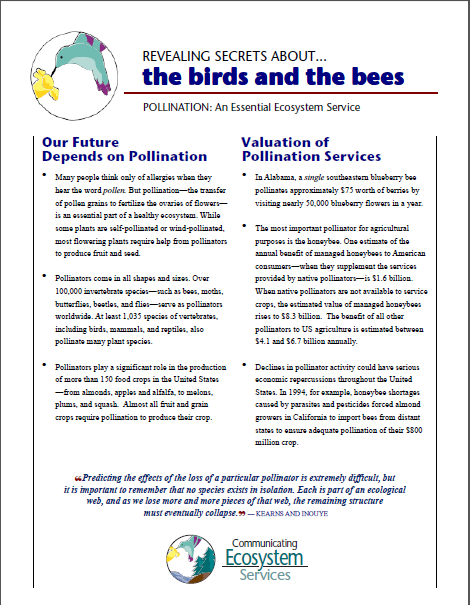
From: Kowalski, K.M. (2003, March). Orchids Trickster Flower: *Odyssey Adventures in Science, 12, 10-12.*

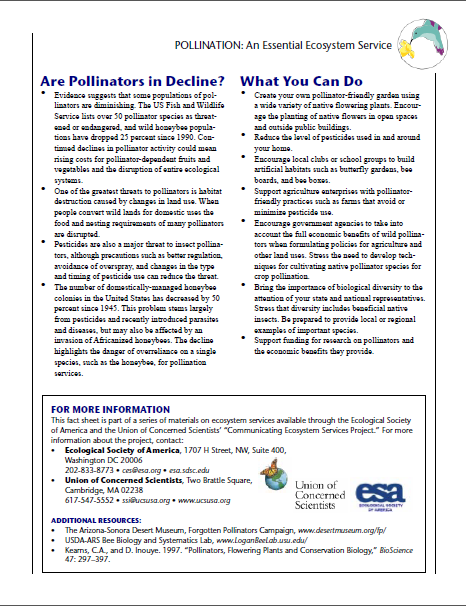






Angiosperm Pollination #4





Angiosperm Pollination #5

From: Riley, P. (1999) *Plant Life: Straightforward Science.* Danbury, CT: Franklin Watts.

